# Development and Pilot Testing of an Organizational Information Technology/Systems Innovation Readiness Scale (OITIRS)

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## ABSTRACT

*Empirical evidence indicates that healthcare organizational readiness for new information technology/systems (IT/S) is crucial to successful innovation. Despite this evidence, limited research has been done to define innovation readiness, and develop and test metrics to measure it. This presentation reports on the third phase in a multi-phased research program focused on healthcare organizational change related to IT/S innovation. In the initial two phases, the concept of IT/S innovation readiness was explored and its sub-dimensions identified and validated. In the third phase, findings from the first two phases were used to develop and pilot test an Organizational Information Technology/Systems Innovation Readiness Scale (OITIRS) for use in healthcare settings. The specific aims of this presentation are to 1) provide background information on the development of the OITIRS, and 2) report pilot testing results that support use of the OITIRS in healthcare informatics research.*

## BACKGROUND

The increased reliance of health care organizations on information technology/systems (IT/S) has resulted in a marked increase in IT/S investment. In 1996, the healthcare industry spent $11.6 billion to purchase products and services to support computerized information systems, a 16 percent increase over 1995 expenditures.[1] In its 2000 report, the Institute for the Future[2] predicted that healthcare organizations would spend an estimated $21 billion in 2000 on new IT/S. As healthcare expenditures for IT/S innovation have increased so has the investment risk associated with these expenditures. In 1999, not-for-profit healthcare organizations experienced a 63% drop in revenue, and this trend has continued as healthcare organizations attempt to address managed care and other regulatory and environmental demands.[3] This has resulted in even less dollars for IT/S investment, and increasingly higher investment risk.

Currently, the healthcare organization failure rate for IT/S innovation is estimated at around 50%[4] This high failure rate is primarily associated with a lack of IT/S innovation readiness assessment and corresponding IT/S innovation risks.[5-7] The concept of organizational innovation readiness has been characterized as the level of fit between the IT/S innovation and the organization.[8,9] Theoretically, a higher level of innovation readiness leads to a lower level of innovation risk, and a more successful IT/S innovation outcome. An important way to identify IT/S innovation risk, therefore, is to assess healthcare organizational readiness for these innovations.[10]

## SCALE DEVELOPMENT

In 1996, a multi-phased research program was initiated that is focused on healthcare organizational change related to IT/S innovation. Initial program studies addressed the concept of innovation readiness. In phase one, a heuristic *Organizational Information Technology/Systems Innovation Model (OITIM)* was developed.[11] The OITIM is supported by four assumptions:

1) IT/S innovations function as healthcare organization interventions.
2) Increased IT/S innovation readiness leads to lower innovation risk and increased innovation success.
3) External environmental factors and organizational characteristics interact to influence the level of IT/S innovation readiness, and the innovation development life cycle.
4) Tightly linked innovation development life cycle sub-dimensions enhance IT/S innovation readiness.[11]

Based on extensive literature review, seven hypothetical innovation readiness sub-dimensions were identified for the model: resources; staffing & skills; technology; knowledge; processes; values & goals; and operations.[11]

In phase two, an exploratory two-round Delphi study was conducted with national healthcare IT/S experts recruited from among members of the Healthcare Information and Management Systems Society (HIMSS). The purpose of the study was to identify and validate OITIM innovation readiness sub-dimensions and their assessment indicators.[11] In Round #1, eight IT/S innovation readiness sub-dimensions were validated: resources; staffing & skills; technology; knowledge; processes; values & goals; operations; and administrative support (Table

1).[11] In Round #2, a total of 316 indicators were identified for the eight validated sub-dimensions. A two-step thematic analysis process was subsequently used to group the 316 indicators into 10 preliminary themes for each sub-dimension (Table 2).[11] The goals of the thematic analysis were to reduce the number of indicators with similar content and meaning, and to establish a more economical number of indicators for use in scale development. In step one, the study investigator sorted each sub-dimension's indicators into ten groups, and created a preliminary theme label for each group. In step two, a seven-member coding team validated preliminary sub-dimension themes and indicators.[11] Table 2 provides a summary, by sub-dimension, of the range of innovation readiness indicators and theme(s) with the highest number of indicators. Additional methodological details can be obtained from the published study report.[11]

Table 1. Validated IT/S Innovation Readiness Sub-Dimensions.[11]

| Sub-Dimensions | Definitions |
|---|---|
| **Resources** | IT/S innovation support mechanisms. |
| **End-Users** | End-user profile. |
| **Technology** | IT/S infrastructure (e.g., hardware, software, networks, wiring, and system integration). |
| **Knowledge** | Organizational knowledge of external and internal driving forces influencing IT/S innovation. |
| **Processes** | Organizational processes that influence IT/S innovation. |
| **Values & Goals** | Individual and organizational values and goals supportive of IT/S innovation. |
| **Management Structures** | Organizational management structures and operations that influence IT/S innovation. |
| **Administrative Support** | Administrative leadership and practices supportive of IT/S innovation. |

Table 2. Range of Innovation Readiness Indicators and Theme(s) with the Highest Number of Indicators by Sub-Dimension.[11]

| Sub-Dimensions | Range of Indicators Per Theme | Theme with Highest Number of Indicators |
|---|---|---|
| **Resources** | 1-6 | •Financial Support |
| **End-Users** | 1-12 | •IT/S Skills and Experience |
| **Technology** | 1-8 | •IT/S Infrastructure and Performance |
| **Knowledge** | 2-8 | •IT/S Budget and Finance Patterns*<br>•IT/S Strategic Planning Patterns |
| **Processes** | 1-6 | •IT/S Communication Process |
| **Values & Goals** | 1-7 | •Corporate IT/S Philosophy |
| **Management Structures** | 1-4 | •Business Plan*<br>•Communication Structure<br>•IT/S Organizational Structure |
| **Administrative Support** | 1-8 | •Executive Champions for IT/S Projects*<br>•Integration of Organizational and IT/S Strategies |

*Sub-dimension themes with an equal number of indicators.

## SCALE PILOT TESTING

In phase three of the research program, an *Organizational Information Technology/Systems Innovation Readiness Scale (OITIRS)* was developed from phase two Delphi study findings. An instrument evaluation study was conducted to assess scale: 1) internal consistency reliability; 2) construct validity; and 3) convergent construct validity using the *Sociotechnical Systems Assessment Scale (STSAS).*[12]

**IT/S Innovation.** The IT/S innovation used to pilot test the OITIRS was a risk management application that is marketed by a large healthcare software/product vendor in Minneapolis, MN. The risk management application is an interactive medical guideline system that provides decision support for evaluating the diagnosis, treatment selection, and resources for each care episode. A tailored curriculum and standardized implementation process is used by the healthcare vendor to support client implementation of the application.

**Setting.** The study was conducted with six US-based organizations that had been using the risk management application for at least a year. The primary services provided by these organizations were case management and utilization management. Their clients included contractors, employers, insurance carriers, schools, and worker compensation claims administrators. Predominant personnel categories included adjusters, data entry staff, case managers, RN utilization coordinators, medical bill reviewers, and claims examiners.

**Sample.** A total of 84 experienced risk management application users from the six organizations volunteered to participate in the study by returning a

survey booklet. The majority had a baccalaureate degree (33%) in nursing (82%), and no experience in IT/S positions (54%). They worked full-time (94%) in, primarily, nurse case manager (26%) and utilization review coordinator (20%) positions. The majority (49%) had been in their current position from 1-3 years. Most respondents reported that they had no experience with: 1) IT/S continuing education programs (60%), 2) participation in IT/S groups (87%), 3) seeking IT/S information (63%), 4) IT/S information sharing within (50%) or outside (76%) their organization, or 5) participation in IT/S projects (67%). The majority (64%) of respondents described their organizations as an insurance company (16%), a preferred provider organization (14%), or a workers compensation insurance company (13%). Respondents reported that the majority (60%) of their organizations had experienced a change 1-3 times within the past year, and that they personally were somewhat (23%) to totally (17%) comfortable with these changes.

**Metrics.** Study metrics included a *Participant Profile Questionnaire (PPQ)*, *Organizational IT/S Innovation Readiness Scale (OITIRS)*, and *Sociotechnical Systems Assessment Scale (STSAS)*.

The *PPQ* was used to collect respondent demographic information. It has 18 items in multiple choice and completion format. Items are presented in two sections. The first section, background information, queries respondents about personal information, such as educational background, IT/S experience, current position characteristics, and innovation behaviors. The second section, organizational IT/S innovation experience, asks respondents about their involvement in organizational IT/S innovation activities, and general perceptions of organizational IT/S innovation patterns.

The *OITIRS* was developed from phase two Delphi study findings for use with a variety of end-users in health care organizations experiencing IT/S innovation. It was designed as an 80-item Likert-type scale that is scored using a 7-point response range from 1 (strongly disagree) to 7 (strongly agree). One additional response option, "unable to respond", was also used in the pilot study. The OITIRS has 8 sub-scales with 10 items each: resources; end-users; technology; knowledge; processes; values & goals; management structures; and administrative support. A total innovation readiness score is determined by summing the scores of all sub-scales. Theoretically, the higher the OITIRS score, the greater the perception of organizational readiness to support IT/S innovation. Prior to distribution to study organizations, the OITIRS was assessed for face validity by 7 clinicians involved in informatics-type roles (e.g., database designer). Reviewers found the scale format clear and easy to read, and estimated that the average response time was about 20 minutes. Reviewers did not think that the scale posed an excessive response burden, and felt that the majority of the items were clear, easy to answer, not redundant, and adequately represented what the scale purported to measure.

The *STSAS* is a six-dimension scale intended for use in determining the extent to which organizational design is consistent with sociotechnical systems principles that produce high levels of commitment and performance.[12] Two STSAS sub-scales, innovativeness and cooperation, assess general organizational readiness, while a third sub-scale, joint optimization, assesses technological readiness.[12] Innovativeness is defined as rewards for innovation, propensity for risk-taking, and extent to which organization leaders and members maintain a futuristic orientation.[12] Cooperation is defined in terms of teamwork, flexibility, changes in organizational structure, and the extent to which individuals and subunits work together to accomplish superordinate goals.[12] Joint optimization is defined as the extent to which the organization is designed to use both its social and technical resources effectively, and the extent to which technology is designed to support teamwork, flexibility, and changes in organizational structure.[12]

The three STSAS sub-scales have a total of 33 Likert-type items that are scored using a 7-point response range from 1 (never) to 7 (always). One additional response option, "do not understand", was also used in the pilot study. Psychometric evaluation of STSAS sub-scales in previous research supported internal consistency reliability with a combined standardized Cronbach's alpha coefficient of .89.[13] Previous research has also supported construct and discriminant validity for STSAS sub-scales, as well as significant, positive correlations between organizational innovation readiness, commitment, and culture.[13] The three STSAS sub-scales were administered with the OITIRS to assess convergent construct validity.

**Procedure.** Study contacts for each of the six participating organizations were identified by the healthcare vendor. Following human subjects approval and agreement of organizational contacts to support the study, a study overview and data collection packets were mailed to organizational contacts. They were asked to distribute the packets to their organization's risk management application users. Data collection packets contained a cover letter explaining the study, a survey booklet, and a

stamped, self-addressed return mailing envelope. Each survey booklet included the *Participant Profile Questionnaire*, *Organizational IT/S Innovation Readiness Scale*, and the *Sociotechnical Systems Assessment Scale*. Risk management application users were instructed in the cover letter to return the completed survey booklet if they were willing to participate in the study. Postcard reminders were sent to organizational contacts for distribution to risk management application users to encourage response. On return, surveys were coded with a respondent and organizational identification number.

## FINDINGS

OITIRS data were analyzed for missing values, item reduction, reliability, and construct validity. The following sections summarize findings for each area.

Missing values ranged from 17 (20%) to 75 (89%) for individual items, with only 31 (37%) of the 80 items having 50% or more valid responses for the 84 subjects. Item specific averages (ISA) were used as substitutes for missing data. The use of ISAs, while commonly done in psychometric pilot research, is rarely addressed in the literature. In this study, ISA use was based on common practice to enable comprehensive psychometric assessment of the new scale.

Item reduction of the 80 scale items was accomplished through the use of a bivariate interitem correlation range of .30 to .65. Items that fell below or above the range were considered either uncorrelated or highly correlated with other scale items and were eliminated from the scale.[14,15] A total of 32 (40%) of the original 80 scale items were eliminated, resulting in a final total of 48 items with 6 items for each of the 8 sub-scales.

Reliability was assessed for the final 48-item scale. Sub-scale internal consistency reliability was supported with standardized Cronbach's alpha coefficients of .83 (resources), .79 (end-users), .84 (technology), .83 (knowledge), .79 (processes), .84 (values & goals), .80 (management structures), and .87 (administrative support).[14,15] Intercorrelations among the 8 sub-scales, which ranged from .37 to .87, were all significant at the 0.01 level and indicated that scale redundancy was not a major problem.[16]

Construct validity of the 48-item scale was supported through confirmatory factor analysis using a principal axis factor (PAF) extraction technique with varimax rotation and a minimum factor loading criterion of .50.[17-19] Findings supported the 8 sub-scales with item factor loading ranges of .59 to .78 (resources), .51 to .73 (end-users), .60 to .79 (technology), .51 to .76 (knowledge), .54 to .80 (processes), .56 to .81 (values & goals), .53 to .78 (management structures), and .58 to .90 (administrative support). Explained variances were 45% (resources), 40% (end-users), 49% (technology), 45% (knowledge), 40% (processes), 48% (values & goals), 41% (management structures), and 54% (administrative support).

Convergent construct validity of the OITIRS was assessed with the *Sociotechnical Systems Assessment Scale (STSAS)* sub-scales of innovativeness, cooperation, and joint optimization.

A psychometric re-evaluation of the STSAS was done prior to convergent construct validity assessment. Findings supported internal consistency reliability with a standardized Cronbach's alpha coefficient of .89 for the combined sub-scales, and individual sub-scale alpha coefficients of .91 (innovativeness), .86 (cooperation), and .88 (joint optimization). Construct validity was supported through confirmatory factor analysis using a principle axis factor (PAF) extraction technique with varimax rotation and a minimum factor loading criterion of .50. Findings supported the 3 sub-scales with the majority of item factor loadings occurring in the ranges of .52 to .85 (innovativeness), .56 to .83 (cooperation), and .57 to .87 (joint optimization). Explained variances were 53% (innovativeness), 39% (cooperation), and 42% (joint optimization).

Convergent construct validity for the OITIRS and the 3 STSAS sub-scales was supported for all OITIRS sub-scales except administrative support with significant correlations that ranged from .24 to .49 (Table 3). With the exception of the

Table 3. Convergent Construct Validity Findings for OITIRS Sub-Scales and Three STSAS Sub-Scales.

| OITIRS Sub-Scales | STSAS Sub-Scales | | |
|---|---|---|---|
| | I | C | JO |
| **Resources** | .26** | .24* | .25* |
| **End-Users** | .34** | .30** | .28** |
| **Technology** | .30** | .26** | .37** |
| **Knowledge** | .30** | .31** | .33** |
| **Processes** | .29** | .30** | .37** |
| **Values & Goals** | .45** | .42** | .49* |
| **Management Structures** | .28** | .27** | .27** |
| **Administrative Support** | .001 | -.018 | .062 |

*$p \# 0.05$ **$p \# 0.01$

**Key:** I = Innovativeness; C = Cooperation; JO = Joint Optimization

administrative support sub-scale, the magnitude of the correlations indicated low to moderate support for beginning convergent validity. These correlations

suggested that the scales were measuring moderately associated but different dimensions of organizational innovation readiness.

## CONCLUSIONS

Study findings supported beginning reliability and validity for the OITIRS. Three limitations, however, mediate these findings and underscore the need for additional psychometric evaluation of the scale.

1) The large number of missing values and use of item specific averages as substitute scores raises concerns. While this is a commonly accepted practice when pilot testing new scales, additional scale testing is required with a larger and more responsive sample to determine if reliability and validity findings remain consistent.

2) The lack of convergent construct validity support for the administrative support sub-scale was an unexpected finding. This may have resulted from the small sample size, and the different focus of administrative support and STSAS sub-scale items. This requires additional exploration given the emphasis on the need for administrative support for IT/S innovation success.

3) The operationalization of organizational innovation readiness was conceptually different between STSAS and OITIRS sub-scales. While there is evidence of convergent construct validity, except for the administrative support, additional assessment with a larger sample is required to further clarify psychometric similarities and differences between the two scales.

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